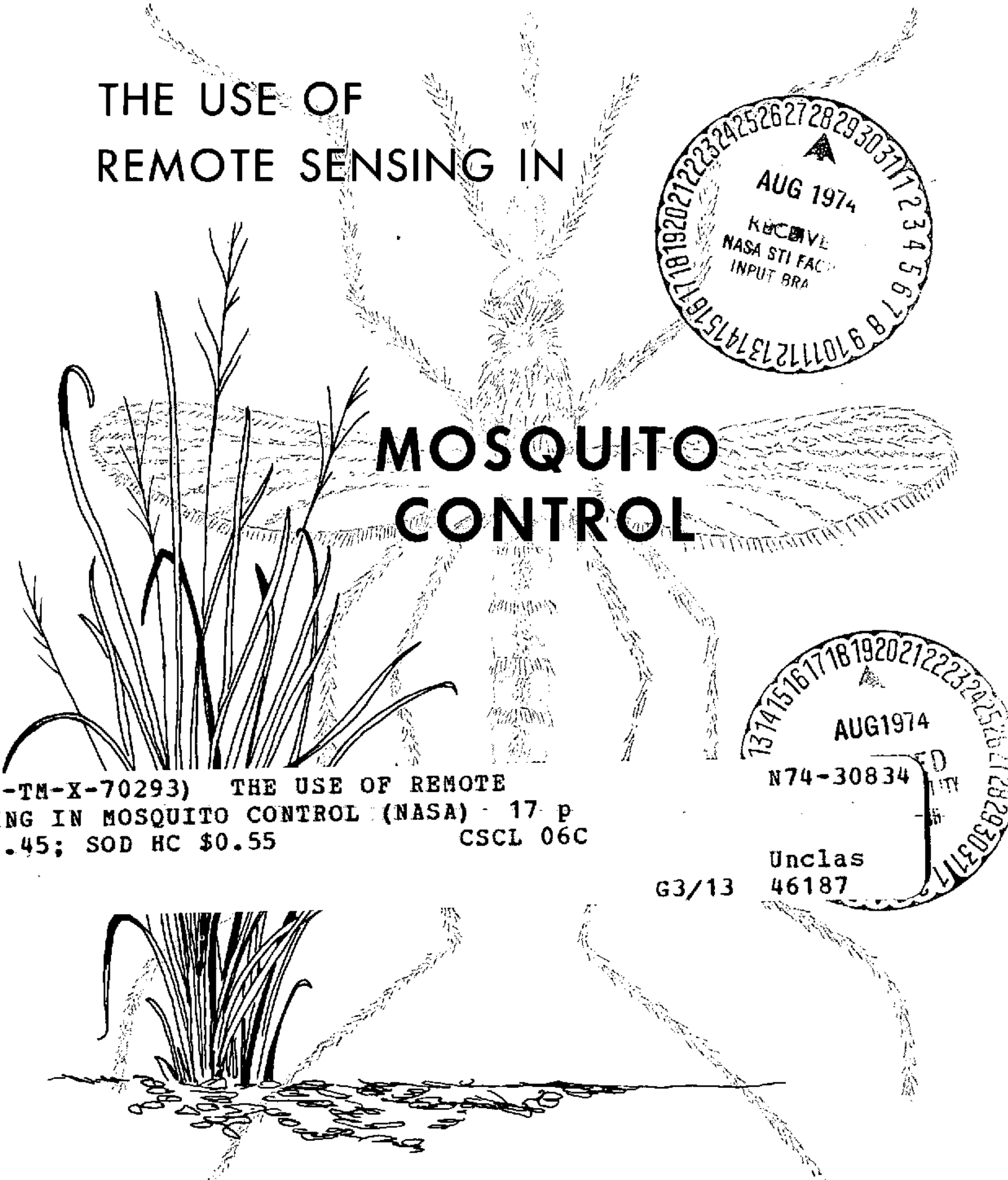
MSC-07644

THE USE OF REMOTE SENSING IN MOSQUITO CONTROL



(NASA-TM-X-70293) THE USE OF REMOTE SENSING IN MOSQUITO CONTROL (NASA) 17 p MF $1.45; SOD HC $0.55 CSCL 06C

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HEALTH APPLICATIONS OFFICE

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Abstract

The technology of remote sensing, developed by the space program for identification of surface features from the vantage point of an aircraft or satellite, has substantial application in precisely locating mosquito breeding grounds. Preliminary results of the NASA technology working cooperatively with a city government agency in solving this problem are discussed in this brochure.

$0.55

Preface

A solution to the problem of mosquito control seemed to have been found when DDT came into general use in the 1940's; however, the use of DDT is now generally banned. Mosquitoes have developed physiological resistance to insecticides. Furthermore, continued wholesale application of chlorinated hydrocarbons for mosquito control is producing concern about possible undesirable environmental effects.

The need for mosquito control is apparent. Uncontrolled, mosquitoes would make the coastal states practically uninhabitable. More significantly, mosquitoes carry the following diseases that are deadly to man and animals.

- Malaria – killer of more persons than any other infectious disease
- Yellow fever
- Dengue
- Asian filariasis
- St. Louis and California encephalitis
- Equine encephalitis (three varieties)

Remote Sensing in Mosquito Control

The Health Applications Office of the Earth Resources Program at the NASA Manned Spacecraft Center (MSC), in a project with the New Orleans Mosquito Control District (NOMCD), recently demonstrated the effectiveness of remote sensing in identifying localized sites of mosquito larval incubation. This specific information is of value in developing new and improved mosquito control techniques.

Because the large-scale release of pesticides in the environment could be a menace to organisms other than mosquitoes, it is extremely important that control activities be directed with the greatest precision possible. This requires a much-improved understanding of the rates of reproduction and the ecologies of the various mosquito species.

Until recently, little heed was given to the study of the ecology of the mosquito. It was enough to know that mosquitoes bred in still or stagnant water, and that by covering such areas with oil or insecticides, the mosquito population could be reduced to an acceptable level.

The NOMCD was one of the first municipal agencies to begin a detailed study of the ecology of indigenous mosquitoes to improve mosquito control techniques. In 3 years of careful observations at an experimental marshland site near the city, the investigation established that a strong empirical relationship exists between specific vegetative communities (*Bacopa monnieri, Distichlis spicata, Spartina patens,* for example) and marshland mosquitoes *Aedes sollicitans, A. taeniorhyncus,* and some *Psorophora* species. *Aedes sollicitans* in particular has a very long range (4 to 40 miles) and is suspected of transmitting equine encephalitis. The study indicated that about 90 percent of the production of *Aedes sollicitans* is dependent on the same ecological set that provides support for these specific vegetative communities. A direct empirical relationship was shown between certain plant communities and the mosquito breeding grounds. Control methods can then be applied selectively to those areas only.

It would be very difficult and economically unfeasible to conduct routine ground-based surveys for specific plant communities in all marsh areas. However, if airborne remote sensors could be used to survey the area rapidly and locate the breeding sites, specific target areas could be identified for the application of mosquito control measures.

In September 1971, remote-sensor overflights of the site studied by the NOMCD were scheduled. The NASA operated its Earth Survey-1 (NP-3A) aircraft at 2000 feet to obtain low-altitude multispectral photographs of the 200-acre test plot between Lake Pontchartrain and Lake St. Catherine. Color, color-infrared, and multiband sensor and film combinations were used in the investigation to assess the feasibility of using remote sensing to recognize the ecological set necessary to produce salt marsh mosquito populations. This cooperative study conducted by NOMCD and NASA MSC is significant as an application of remote-sensing technology to a public health problem. This methodology is applicable in other areas involving arthopod-borne disease vectors and soil- or water-borne diseases.

Methodology

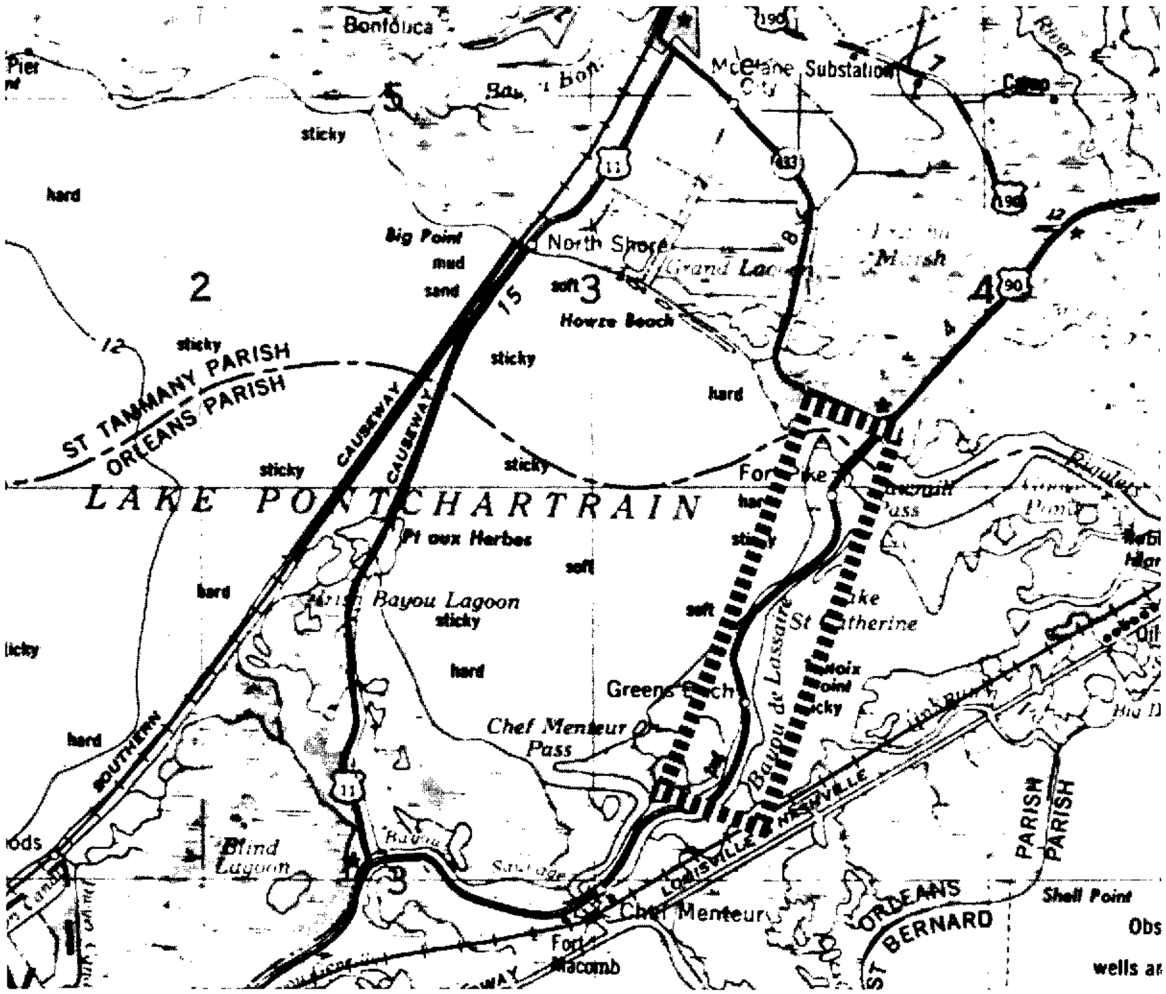
The methodology involves the following steps.

1. Identification of a ground feature indicator plant species that is directly or empirically linked to a human or animal disease
2. Selection of a remote-sensing system sensitive to the indicator species
3. Collection of the remotely sensed data
4. Utilization of analysis techniques appropriate to the degree of differentiation that is necessary

Of these steps, the first is the most critical. Evidence linking the problem under study to phenomena observable by remote sensing must be firmly established. It is from this basic protocol that new interpretative techniques and automatic data processing can be used to facilitate large-scale aerial assessments of the environment from which inference about public health problems may be drawn.

How It Was Done

The first step in establishing the precise locations of mosquito breeding sites is a thorough study of an area where mosquitoes are known to breed. The NOMCD conducted a 3-year study of the ecology of coastal marsh mosquitoes at the site outlined on the map.

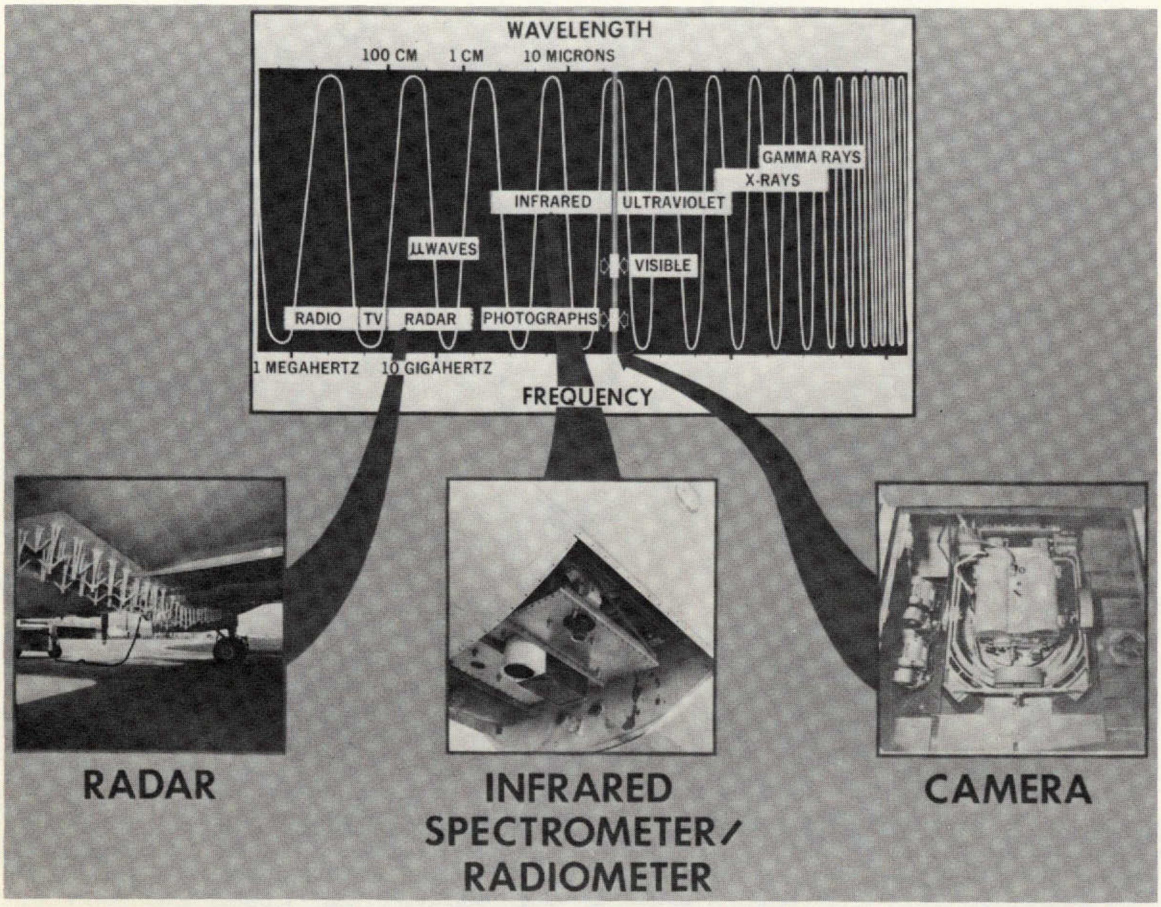


Lake Pontchartrain ecological research site

Swamp buggy takes researcher to inaccessible locations.

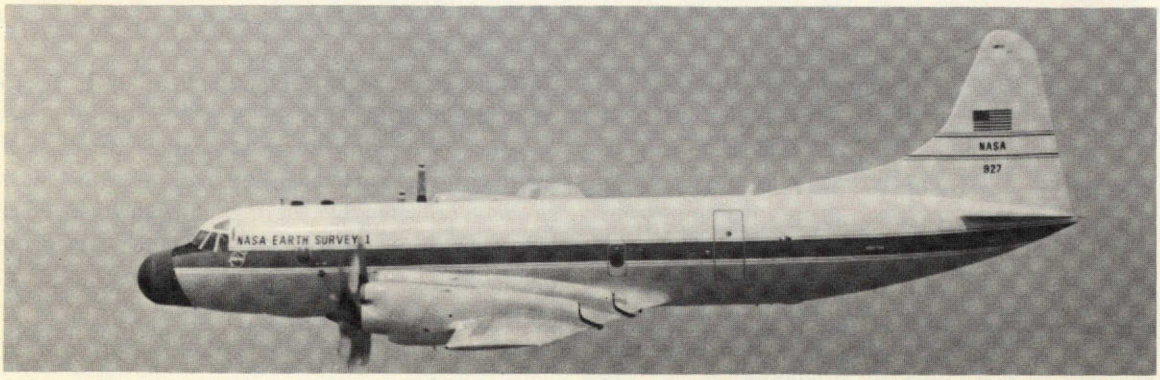
Detailed data on vegetative types, water and soil composition, and mosquito reproduction were collected in every part of the research site. Examination of all the data showed a strong empirical relationship between several plant communities and marsh mosquitoes. This discovery provided the basis for the use of remote sensing. The image resolution of the sensors is not adequate to register the mosquito or its larvae but is certainly more than adequate to image the plant communities.

The second step involved the MSC Health Applications Office and the NASA Earth Resources organization. Taking into consideration the bands of the electromagnetic spectrum that would be more strongly reflected by the incriminated plant communities, the sensors to be tested were selected for their ability to identify these plants.



Typical sensors in relation to their bands of sensitivity

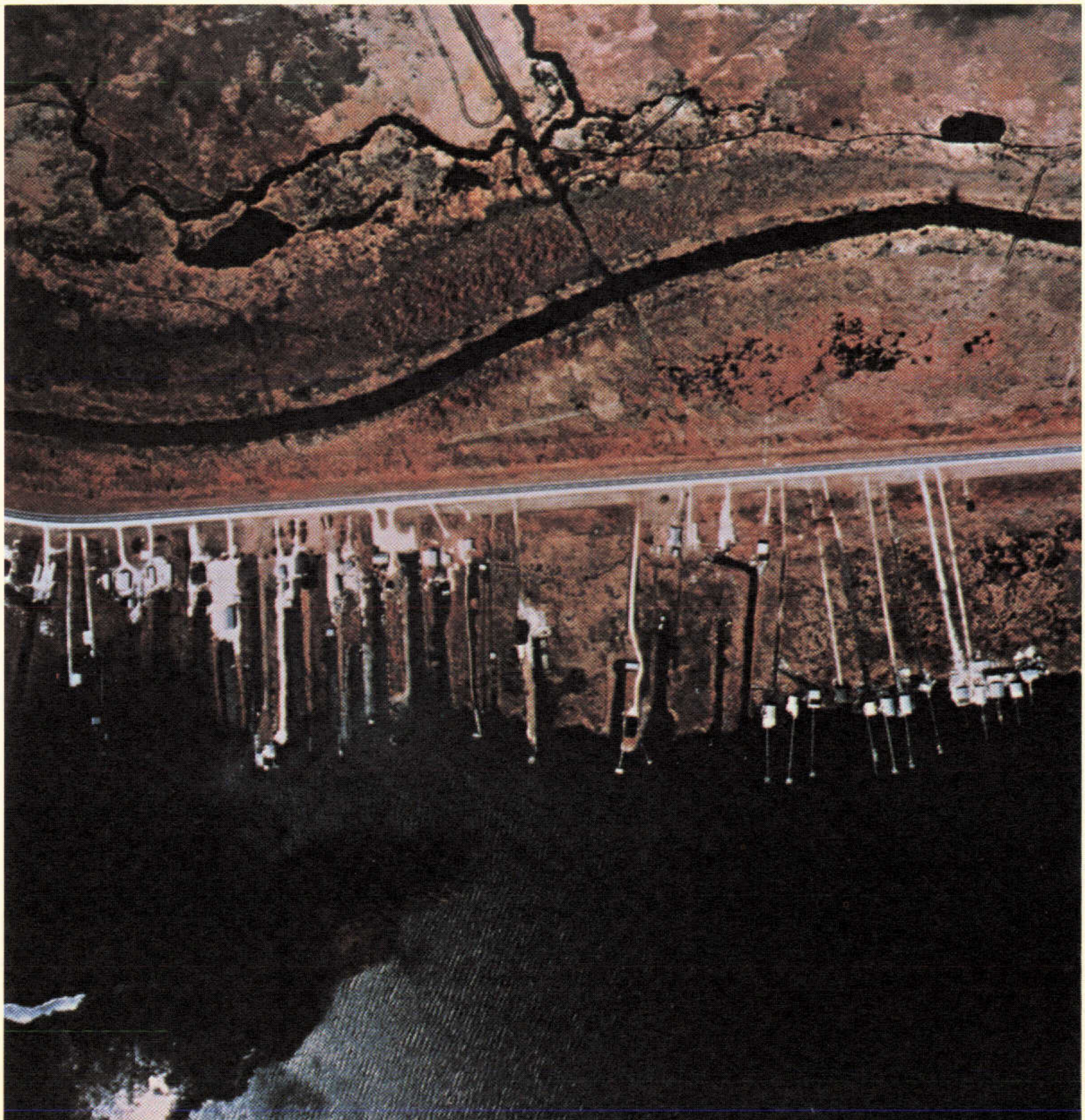
The third step involved actual collection of the remote-sensor data. This was done by the NASA Earth Survey-1 aircraft operating a multiband cluster of 3-inch focal length KA-62 cameras over the research site at an altitude of 2000 feet.



Earth Survey-1 used in the experiment

During the overflight, researchers collected ground data to make careful measurements of typical conditions. The data collected are called ground truth, and some degree of this activity is necessary for most remote-sensing operations.

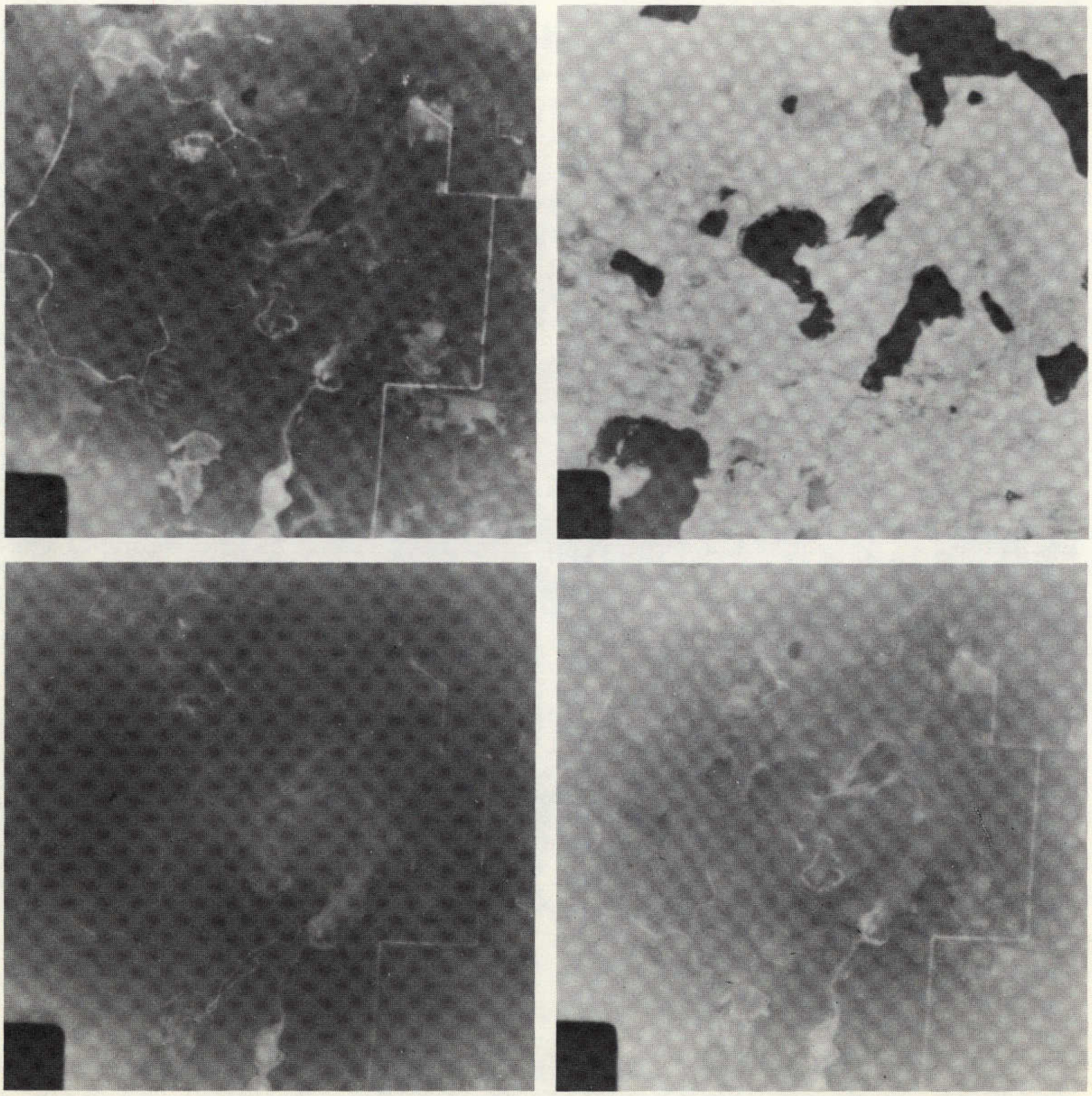
The fourth step was analysis of the remote-sensor data, using ground-truth data for verification. Color infrared photography has been used to identify many types of vegetation and can even serve as a guide to the health of plants. However, it cannot discriminate the differences of heterogeneous vegetative communities.



Color infrared photograph of a portion of the experiment site

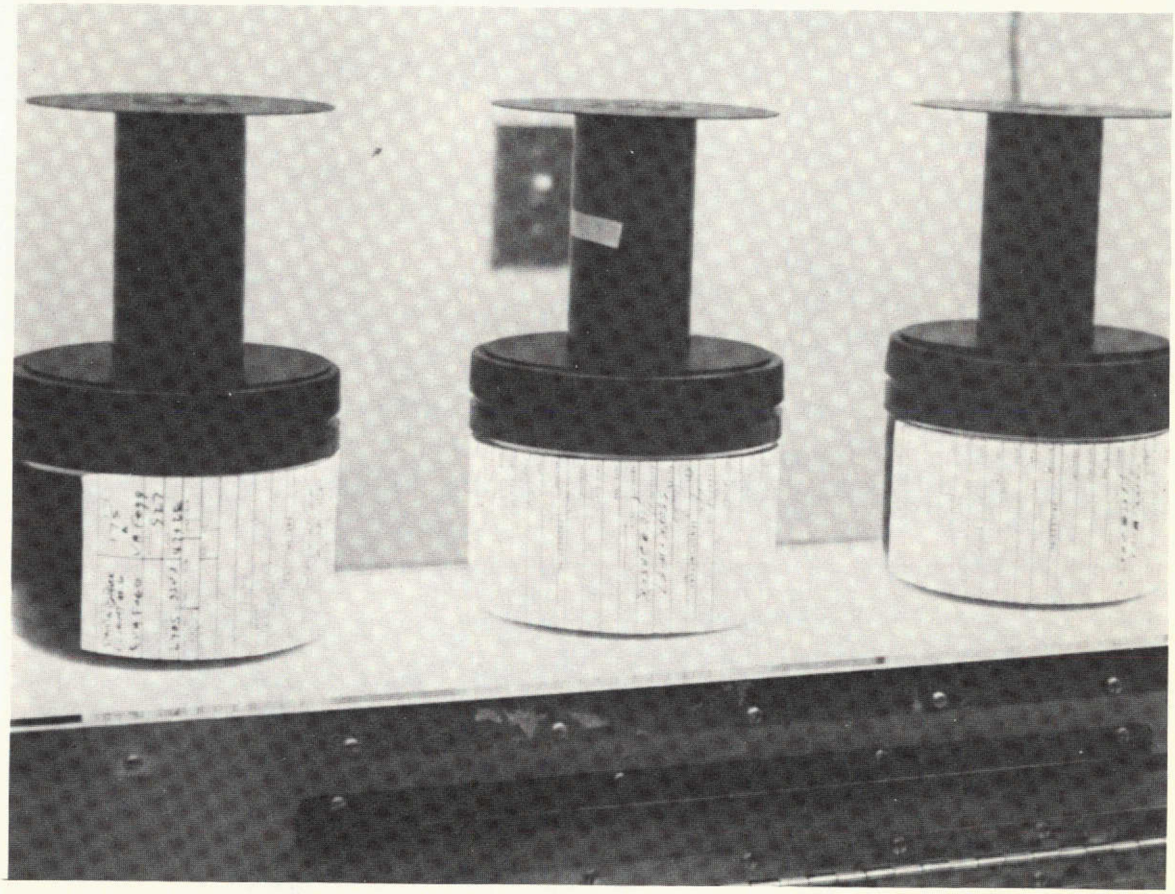
The most successful technique in fine discrimination of the selected plant communities from other major botanical communities proved to be multiband camera imagery enhanced by electronic manipulation.

Multiband cameras are operated in clusters of four to six, each with a film/filter combination to record a different band of the visible or near-infrared wavelengths.



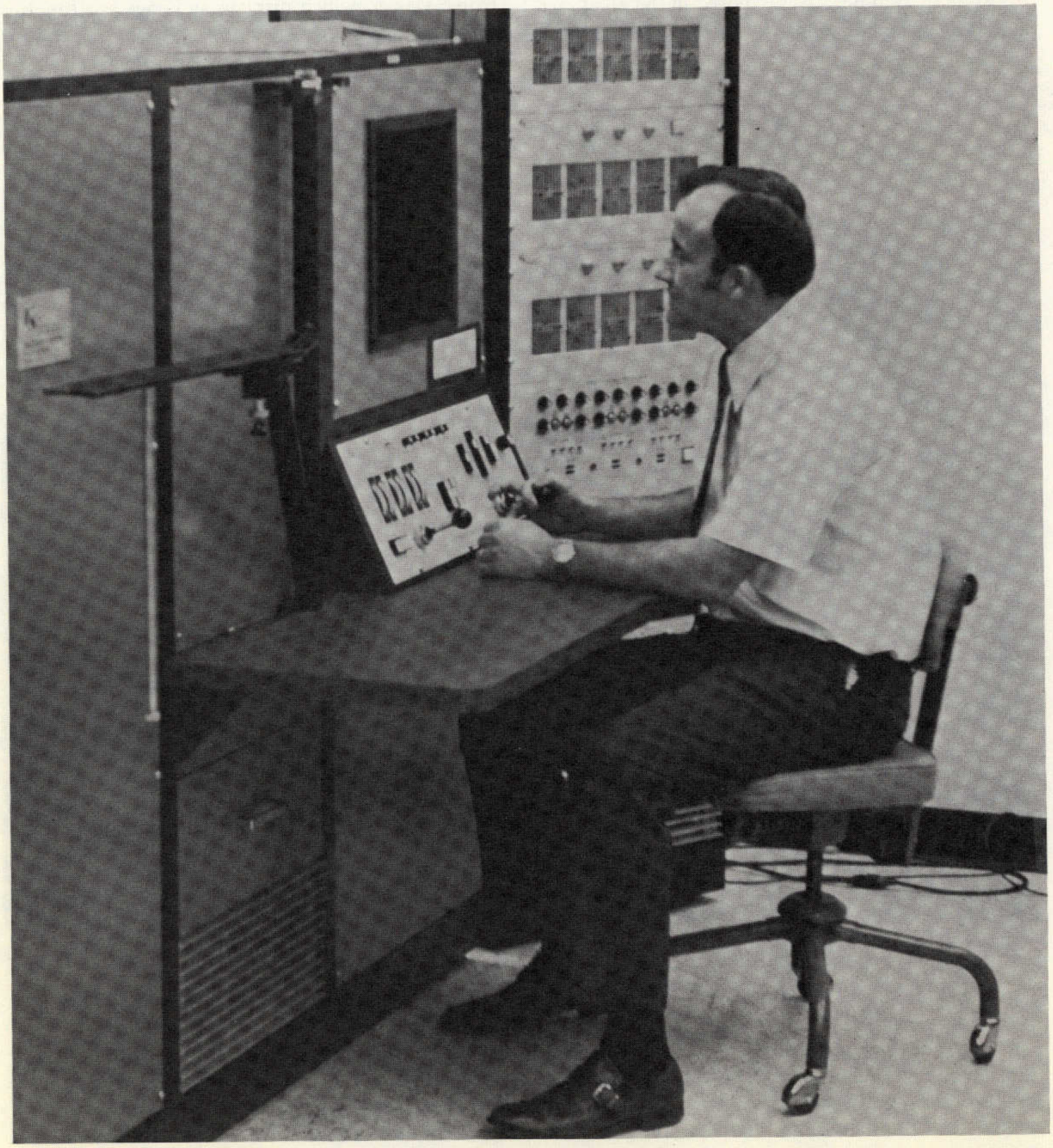
Typical multiband camera imagery

Rolls of film negatives exposed in the green, red, and near infrared bands were inserted in an electronic viewer, which displays an image as a function of film emulsion density.

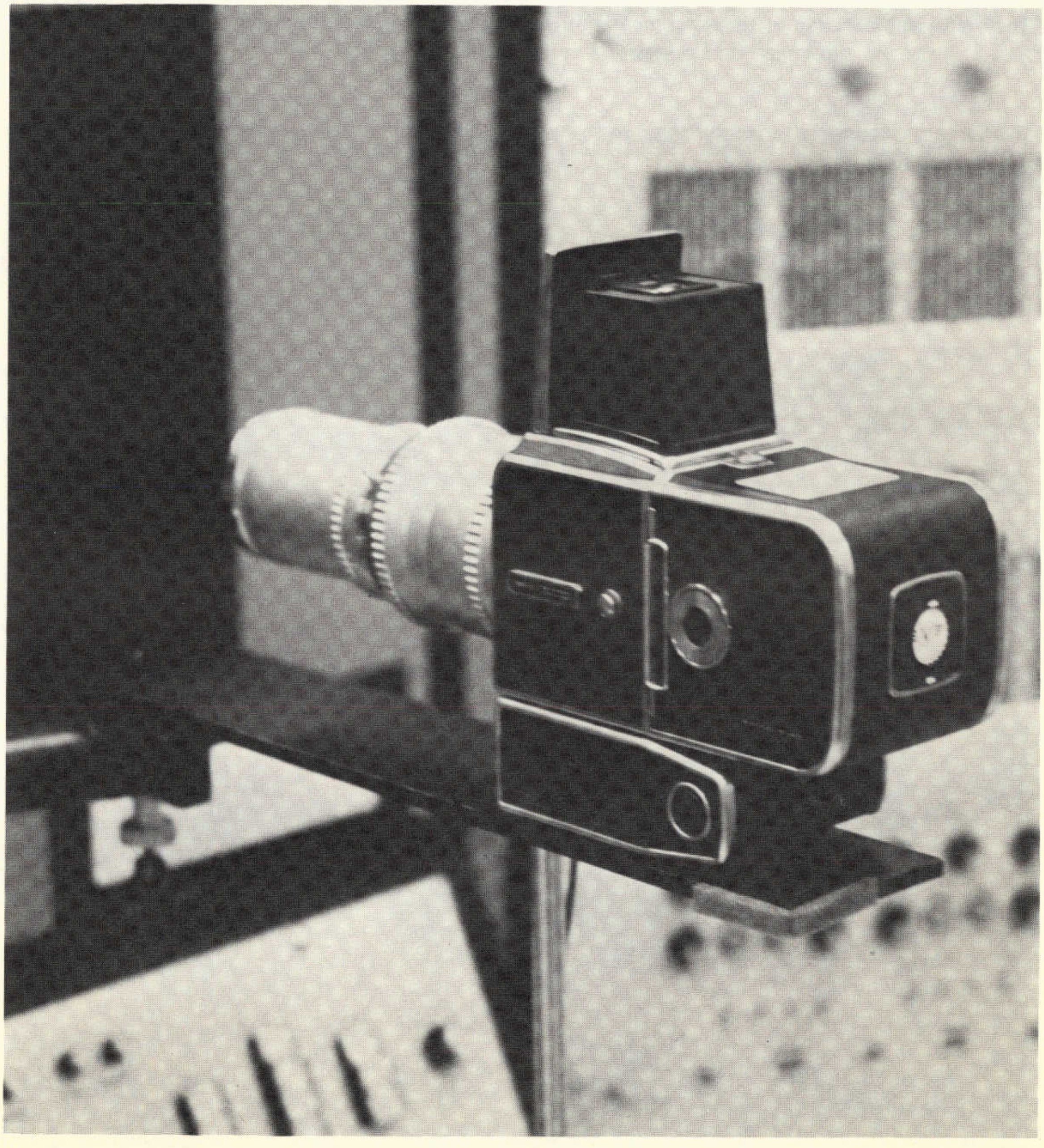


Three rolls of film positives were inserted in the electronic viewer.

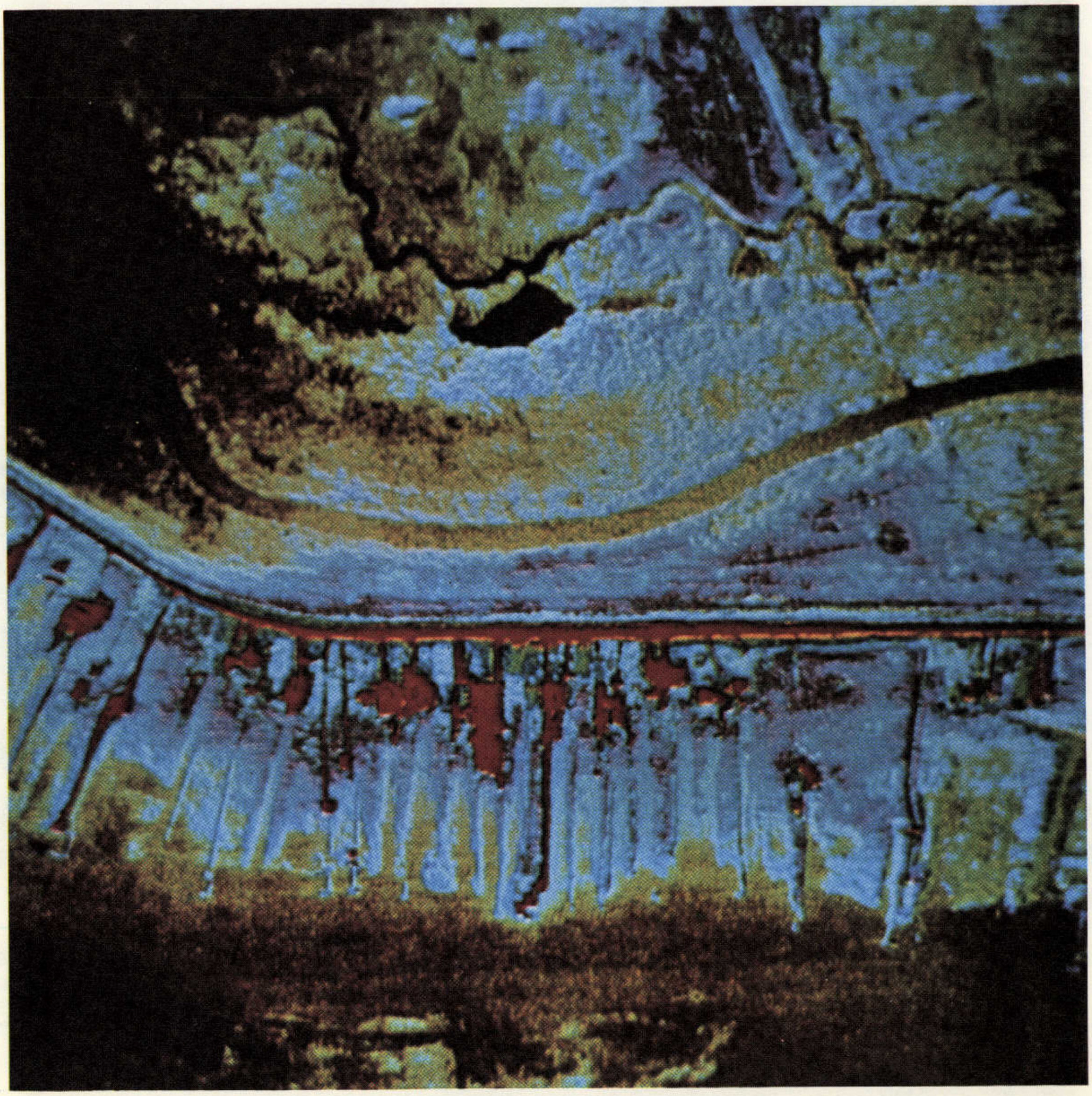
By manipulating controls of the electronic viewer, arbitrary colors may be assigned to any increment of film emulsion density. Images from separate rolls may be viewed separately or in any combination. Other enhancing techniques, such as exaggeration of the edges between tonal or color differences, may be used. Skillful operation of the electronic viewer can extract and display the maximum amount of pertinent information from the original photographic imagery. To make a permanent record of the image on the viewer, the analyst uses a copy camera mounted on the cabinet.



Photoanalyst operates electronic viewer.


Camera used to copy images from electronic viewer

The following photographs were taken directly from the electronic viewer with the copy camera. They represent a section of the experimental site in New Orleans and show the effectiveness of remote sensing in locating the plants associated with marsh mosquito breeding grounds. Arbitrary colors were assigned to specific film densities and edge enhancement was used.



Electronic image from film exposed in the green band

Electronic image from film exposed in the red band

Electronic image from film exposed in the near infrared band

Electronic image of red and near infrared bands combined was also enhanced by decreased density slicing.

The previous photographs show the remarkable versatility and precision of remote-sensing techniques. The images formed by the film exposed in red, green, and the near infrared bands are presented to illustrate the way the electronic viewer works. Only when red and the near infrared bands are combined with decreasing density slicing are the more subtle differences markedly observed, which reveal even the most minor vegetative communities and interface differences. Classifications in the annotated photograph have been confirmed by double-blind field checks and found extremely accurate.

The importance of the proof of this remote-sensing capability is recognized when one recalls that 90 percent of the production of the *Aedes sollicitans* mosquito is dependent on the same ecological set that provides support for the discriminated vegetative communities in the New Orleans area.

Conclusion

The remote-sensing techniques described here have been useful in identifying mosquito larval incubation areas in a small test site. The immediate research tasks are to prove that such methodology is valid over large unknown areas and to simplify data acquisition and processing so that it may be effectively utilized by local mosquito control districts as well as by national and international agencies. In addition, work is currently underway to compare the results of the New Orleans study with data obtained using electronic multispectral scanning techniques and broad observations from the Earth Resources Technology Satellite.

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